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GB 1242947 A	EP 0449467 A1	US 5237153 A
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(54) Battery powered electric arc welder

(57) An arc welder has a switch mode power supply with a control circuit 14 which repeatedly turns a transistor T on and off, so that an inductor L stores energy from a rechargeable battery 10 when the transistor T is on and then discharges the stored energy to welding electrodes 12, 16 when the transistor T is off. The circuit 14 may be responsive to a feedback signal from a current sensing resistor R and may operate the transistor T at a switching frequency of 10KHz. The duration of each ON period of transistor may be adjusted by a manually operated power setting control. Additional controls may set voltage and short circuit power. The controls may be located on a hand-held unit (24, Fig.2) which incorporates the welding electrode 16 and may also have a welding wire feeding speed controller.

The battery 10 may be a lead acid battery charged from a mains supply or from a vehicle alternator, a pedal or hand-powered alternator/dynamo, or a solar unit. The battery charging current may be increased during welding.

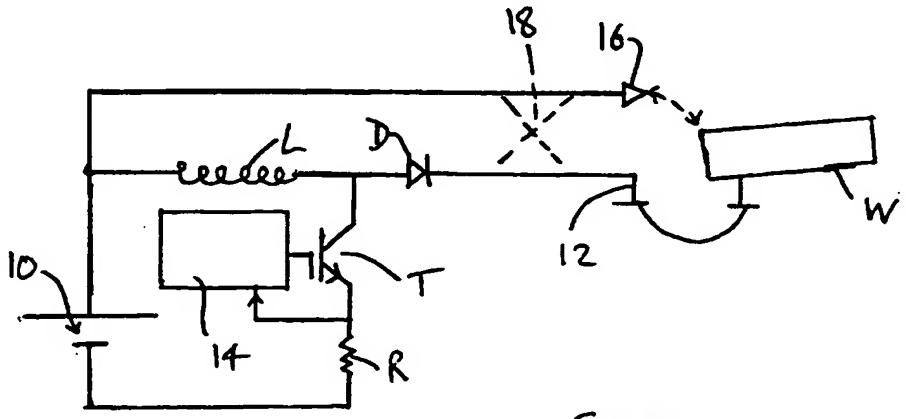

FIGURE 1

GB 2 316 244 A

The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1995

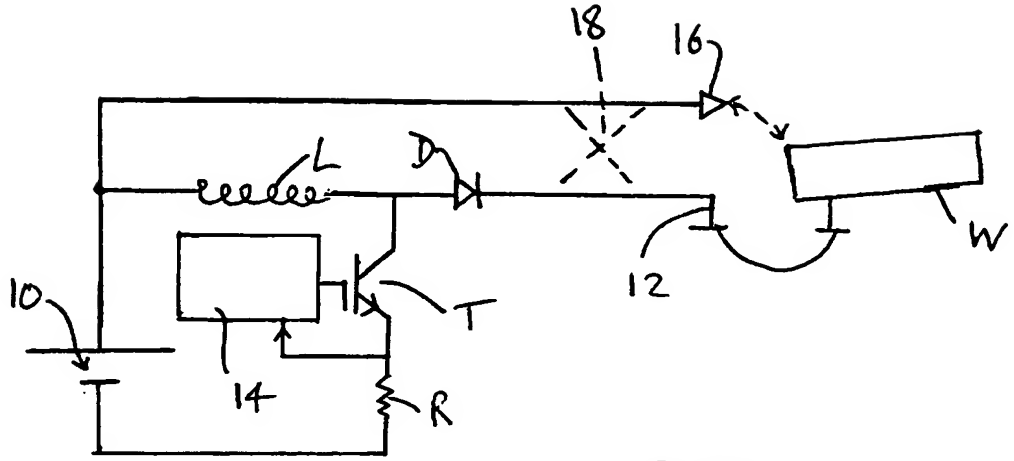

FIGURE 1

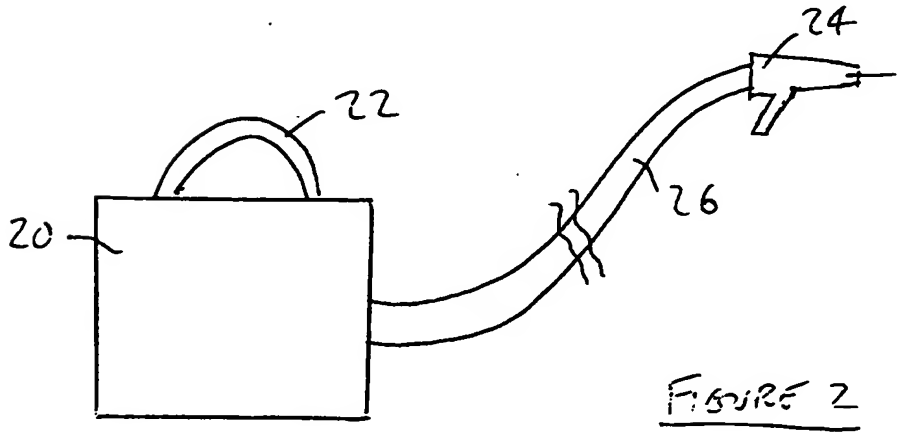

FIGURE 2

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Electrical Welding Apparatus

The present invention relates to an electrical welding apparatus.

Hitherto, electrical welding apparatus have been powered from the mains, because the transformer/rectifier arrangements which they employ need to be capable of providing full power at all times.

We have now devised an electrical welding apparatus which avoids the above drawback.

In accordance with the present invention, there is provided an electrical welding apparatus which comprises a rechargeable battery, means for recharging the battery, a charge storage means, an electronic switch and control means for periodically turning the switch on to charge said charge storage means and then turning the switch off so that the charge storage means discharges through electrodes connected across the charge storage means.

The apparatus accordingly uses a switch mode power supply, which uses the charge storage means to provide a voltage which is boosted, relative to the battery voltage, to a level required for welding.

The apparatus avoids the use of a transformer and also avoids the use of a high power on/off switch (which is an expensive component).

Preferably the electronic switch is a power transistor which is controlled by a circuit which supplies a train of pulses. Preferably a manual power control is provided, to vary the duration of each pulse (the ON time of the switch). Preferably a feedback circuit is provided, and further controls the duration of each pulse in accordance with the charging current which flows when the switch is ON, to regulate that current.

Preferably the charge storage means comprises an inductor having one end connected to a first terminal of the battery and its other end connected via a rectifier to a first electrode. A second electrode is connected to the first terminal of the battery. The switch is connected from the

junction between the inductor and diode, to the second terminal of the battery. When the switch is ON, current passes from the battery, through the inductor and switch, and so charges the inductor: at this time however, the rectifier is reverse-biassed. When the switch turns OFF, the inductor discharges, developing a boosted voltage which forward-biasses the rectifier and a high discharge current passes from the inductor, through the diode and workpiece and returns to the first terminal of the battery.

An embodiment of electrical welding apparatus will now be described by way of example only and with reference to the accompanying drawings, in which:

FIGURE 1 is a circuit diagram of a welding apparatus in accordance with the invention; and

FIGURE 2 is a schematic view of the apparatus.

Referring to Figure 1 of the drawings, there is shown an electrical welding apparatus which is powered from a 12 volt rechargeable battery (e.g. a lead-acid battery) 10. The positive terminal of the battery 10 is connected to one end of an inductor L, the other end of which is connected via a diode D to a terminal 12. A transistor switch T is connected from the junction between the inductor L and diode D, to the negative terminal of the battery 10. A control circuit 14 controls the switch T. A feedback signal is developed across a resistor R in the emitter circuit of the switch T and applied to the control circuit 14. A welding electrode 16 is connected to the positive terminal of the battery 10.

In use of the apparatus, the terminal 12 is connected to the workpiece W, and the welding arc is struck between the welding electrode 16 and the workpiece W. The control circuit 14 provides a train of pulses for switching the transistor switch T on and off. Each time switch T is switched on, current passes from the battery 10, through inductor L and the switch T, so storing energy in the inductor L: at this time, should the electrode 16 touch the workpiece W, the cathode of the diode D is held effectively at 12 volts, via the workpiece W, electrode 16 and the line to the positive terminal of the battery, such that the diode is reverse biassed and no current passes through it. Then when the transistor T is switched off,

the energy stored in the inductor L dissipates, the voltage at the junction between the inductor L and diode D rapidly rising (typically to 36 volts) such that a high current (typically of the order of 150 amps) flows from the inductor L, through the diode D, the workpiece W and via the arc to electrode 16 and back to the positive terminal of the battery.

The apparatus further comprises an arrangement for recharging the battery 10. This recharger may be powered from the mains, vehicle alternators/dynamos, pedal or handle-powered alternators/dynamos, or solar power for example.

Typically, the control circuit may provide switching pulses at a repetition frequency of 10kHz. A power control setting may be included, to set the time duration for which the transistor T is ON each time. The feedback signal developed across resistor R is a measure of the current flowing through the transistor, and is compared with a value, selected by the power control setting, to regulate the duration of each control pulse applied to the transistor. Additional controls can be provided to set the voltage, short circuit power and pulsing flexibility.

It will be appreciated that the transistor T is conductive for very short time durations. When the transistor T is OFF, current flows only whilst the inductor L discharges. it will be further appreciated that the circuit avoids the use of a high power transformer and further avoids the use of an ON/OFF switch. The apparatus is smaller and tighter than conventional welders of comparable power rating. A further feature of the circuit is that it is fail-safe.

As shown in Figure 2, the battery 10 and power electronic circuit may be contained within a housing 20, typically provided with a handle 22 so that it is readily portable. A hand-held unit 24, incorporating the welding electrode 16, is coupled to the housing 20 by a flexible pipe 26. Preferably the power control setting and other manual controls are incorporated in the hand unit.

In the case of a lead-acid battery, then if this recharges too quickly, hydrogen gas will be vented off. The apparatus incorporates a charge monitor which monitors, and controls, the charge current such that the venting of hydrogen

is minimised. Further the charge current can be linked to the weld current such that the charge current is increased during welding and decreased to a safe limit (approximately 10% of the battery rating) during quiescent periods. Optionally the apparatus will also incorporate a voltage monitor to shut down the welder if the battery goes below a certain, preset, voltage and will only allow its use again once the battery has been recharged to a preset value.

The housing 20 also includes a ventilating fan arrangement for cooling the power electronics and for preventing any hydrogen building up to an explosive level.

The welding apparatus which has been described is suited to gasless MIG welding, in which a wire which incorporates flux is fed, motor-driven, from within the housing 20, through the pipe 26 and to the hand-held unit 24. It may instead be used for gas-mode MIG welding, in which the wire does not include flux but an inert gas is fed through the pipe 26 to emerge from a nozzle of the hand held unit 24: in this case however, changeover terminals (indicated at 18 in Figure 1) must be used. The motor for the welding wire is preferably of variable speed, with its manual speed-controller preferably included in the hand-held unit 24.

Claims

1) An electrical welding apparatus comprising a rechargeable battery, means for recharging said battery, a charge storage means, an electronic switch and control means for periodically turning said switch on to charge said charge storage means and then turning said switch off so that said charge storage means discharges through electrodes connected across said charge storage means.

2) An electrical welding apparatus as claimed in Claim 1, wherein said electronic switch is a power transistor which is controlled by a circuit which supplies a train of pulses.

3) An electrical welding apparatus as claimed in Claim 2, comprising a manual power control for varying the duration of each pulse.

4) An electrical welding apparatus as claimed in Claim 3, comprising a feedback circuit for controlling the duration of each pulse in accordance with the charging current which flows when the switch is ON, to regulate that current.

5) An electrical welding apparatus as claimed in any preceding claim, wherein said charge storage means comprises an inductor having one end connected to a first terminal of the battery and its other end connected via a rectifier to a first electrode, a second electrode being connected to the first terminal of the battery, and said switch being connected from the junction between said inductor and said rectifier to a second terminal of said battery.

6) An electrical welding apparatus, substantially as herein described with reference to the accompanying drawings.

The Patent Office

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Claims searched:	1 to 6	**Date of search:**	8 September 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

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Int Cl (Ed.6): B23K 9/09, 9/095, 9/10, 9/20, 11/24, 11/26, 11/28.

Other: ONLINE - WPI.

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X,E	GB2301495A	(COUNTERTONE) - Fig.1; Abstract	1-4 at least
Y	GB1574880	(SHINKO) - Figs.1,2	1 at least
Y	GB1480102	(GRUNDY) - Figs1-3	1,2 at least
Y	GB1242947	(CONTINENTAL CAN) - Fig.1	1,2 at least
Y	EP0449467A1	(POWCON) - Fig.3	1 at least
Y	US5237153	(GILLILAND) - Fig.1	1,2 at least
Y	US4310744	(OSAKA TRANSFORMER) - Fig.7	1 at least
Y	US4182949	(POWERS) - Fig.5; column 6 lines 29-43	1,2 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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